4-28-2009

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When to Inoculate Soybean Seed in Iowa

by Palle Pedersen, Department of Agronomy

Soybean is a legume with a seed content of approximately 38 percent protein. Because of its seed protein concentration, soybean has a large nitrogen demand and continues to increase as yield increases. Total nitrogen accumulation for soybean is supplied by two sources: the nitrogen fixation and from the residual soil nitrogen pool.

Nitrogen (N) fixation is the symbiotic process of converting atmospheric nitrogen into a usable form for the plant and is critical for producing high soybean yields. For nitrogen-fixation to occur, the nitrogen-fixing bacteria known as *Bradyrhizobia japonicum* need to be readily available in the soil or must be applied to the seed.

When the soybean seed germinates, the rhizobia bacteria invade the root hairs of the seedling and begin to multiply. Nodules, which are structures that house the bacteria, form on the roots. Under field conditions, nodule formation can be seen shortly after emergence but active nitrogen fixation does not begin until about the V2 to V3 growth stage. After this, the number of nodules formed and the amount of nitrogen fixed increase with time until about R5.5 (midway between R5 and R6), when the fixation decreases sharply.

Nitrogen fertilization of soybean is not recommended because it typically does not increase grain yields in Iowa production systems. The total number of nodules that form decreases proportionately with increasing amounts of applied N. In addition, N fertilization will inactivate nodules or cause them to become inefficient, proportionately to the amount of N applied. Although the soybean plant can use both symbiotically fixed N from bacteria and inorganic soil N (both mineralized and fertilizer N), soil N is used in preference to fixed N if available in the soil.

Soybean does not respond with increased yield to the addition of N, even though plants remove a significant amount of it from the soil. In Iowa soils, which have appreciable organic matter and mineralized N, up to 50 percent or more of the total N accumulated by soybean can come from the soil system rather than N2 fixation. Increasing N supply by adding fertilizer, animal manure, sludge, or a green manure crop simply substitutes N from these sources for N that would otherwise be fixed by the bacteria in nodules on the roots, and hence an economically wasted input.

Today, most fields in the Midwest have experienced soybean in the rotation, likely increasing the population density of *Bradyrhizobia* bacteria in the soil. Improved inoculant technology coupled with higher commodity costs, ease of application, and low cost inoculant products have many growers reconsidering the use of inoculants.

I have since 2003 conducted numerous inoculation trials every year to assess new inoculants on the market. Overall, I have not seen a consistent response to use of soybean inoculant in fields in Iowa with a history of soybean. Current recommendations for states of the upper Midwest are to use an inoculant if

fields have no history of soybean production in the past three to five years, soil pH is below 6.0, sandy soil, low organic matter, or have been flooded for more than a week.

Consider fields that were flooded last year

This year, we need to consider the fields that were flooded last spring. Some of these fields were flooded over an extended period of time, and plants were injured or died. These fields may need to be inoculated because the anaerobic conditions may have reduced the level of Bradyrhizobia bacteria in the soil.

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This article was published originally on 4/28/2009 The information contained within the article may or may not be up to date depending on when you are accessing the information.